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Use of microbial parameters to assess treatment methods of municipal sewage sludge applied to grey forest soils of Tatarstan

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Abstract

The benefits and limitation of sewage sludge application as an organic fertilizer need to be investigated for various procedures of sludge treatment. For this purpose, three types of municipal sewage sludge of the city of Kazan (Tatarstan, Russia), i.e., anaerobically digested, composted and untreated, were added to field plots of a grey forest soil (Haplic Greyzem) and planted to spring barley (*Hordeum distichum* L.). Soil microbial biomass carbon, respiration and N_2-fixing activity as indicators of soil fertility as well as plant yield and the metal content in soils and plants were measured to determine the most suitable type of sludge as organo-mineral fertilizer.

As shown, sludge additions resulted in significant increase of metal contents in the soil, although the maximum metal concentrations found remained lower than the current critical limits established for Russia. The application of composted sludge to soils was followed by the increase in microbial biomass (about 1.9–4.4-fold), basal respiration (about 2.3–6.3-fold) and in N_2-fixing activity (about 2.1–35-fold) in comparison with the parameters found for control soil without any sludge addition. The application of anaerobically digested sludge had no significant effects on microbial biomass and activity. In the case of untreated sludge application, a significant decrease in N_2-fixing activity was noted. Beneficial effects on microbial biomass and activity were greater in plots that had received composted sludge. In the absence of any detrimental effect on crop quality, this study lends support to using this type of sludge as the organo-mineral fertilizer for grey forest soil of Tatarstan.
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Keywords: Sewage sludge; Soil microbial biomass; Respiration; Heavy metals; Nitrogen fixation; Tatarstan

1. Introduction

The agricultural practices used to increase productivity have often exerted adverse effects on soil quality and fertility. Recently, the use of sewage sludge as an organic fertilizer has become a common practice. It is considered a viable alternative to the landfill or incineration as a disposal method. Since sewage sludge contains plant nutrients and organic matter, it may be beneficial to soils and their productivity. It provides a useful organic amendment to improve soil properties, i.e., soil structure and nutrient content. However, sewage sludge can often contain considerable amounts of heavy metals and toxic organics. Due to their persistence and potential toxicity, they may pose a risk to ecosystems.

Much research has been performed on the use of the sewage sludge as crop fertilizers (Van den Berg, 1993; Hue, 1995; Merzlaya et al., 1995; Gardiner et al., 1995; Selivanovskaya et al., 1997; Selivanovskaya

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